Black Creek and Lamoille River Floodplain Restoration Project

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Introduction

A large floodplain restoration project was completed in 2008 in northern Vermont where approximately 6 miles of former rail embankment were removed to reconnect more than 200 acres of historic floodplain (Summarized in Schiff et al., 2008). The total project cost was $550,000 and resulted in excavation of 60,000 cubic yards of floodplain fill that led to the return of attenuation of fine sediment and associated nutrients on reconnected floodplains (Figure 1).

Vermont has conducted fluvial geomorphic assessments on nearly 1,500 miles of streams and rivers since 2003. A major finding from the statewide data set is the degree to which river channels are disconnected from their floodplains. Comparing the existing annual flood stage to the stage required for floodplain access, Vermont found that 75% of assessed miles are moderately to severely incised (Kline and Cahoon, 2008). Projects to restore floodplain function have become an important part of Vermont's River Management Program to reduce erosion hazards and restore water quality and river habitat.

FIGURE 1
Black Creek and Lamoille River Floodplain Restoration Project Summary

An agreement between the Vermont Agency of Natural Resources and the Vermont Agency of Transportation established a partnership in pursuing floodplain restoration along the former rail line following track removal and federal rail banking. The end of rail operations was largely the result of regular flood damage and a decrease in regional freight traffic (Pelletier, 2003). The rail line is leased by the Vermont Association of Snow Travelers that also supported the floodplain restoration effort. The Natural Resources Conservation Service funded a portion of the project along with the Vermont Agency of Natural Resources. The project was made possible by the willingness of landowners to naturalize flooding on their lands to achieve the project goals of capturing sediment and nutrients, reducing local flood and erosion hazards, improving water quality, and enhancing habitat. The diverse group of participating project stakeholders indicates floodplains reconnection can be compatible with a diverse set of land uses including agriculture and recreation.

Reconnected floodplains are now periodically inundated (Figure 2) and observable sediment deposition is taking place following flooding (Figure 3).

FIGURE 2
Floodplain Inundation along Black Creek

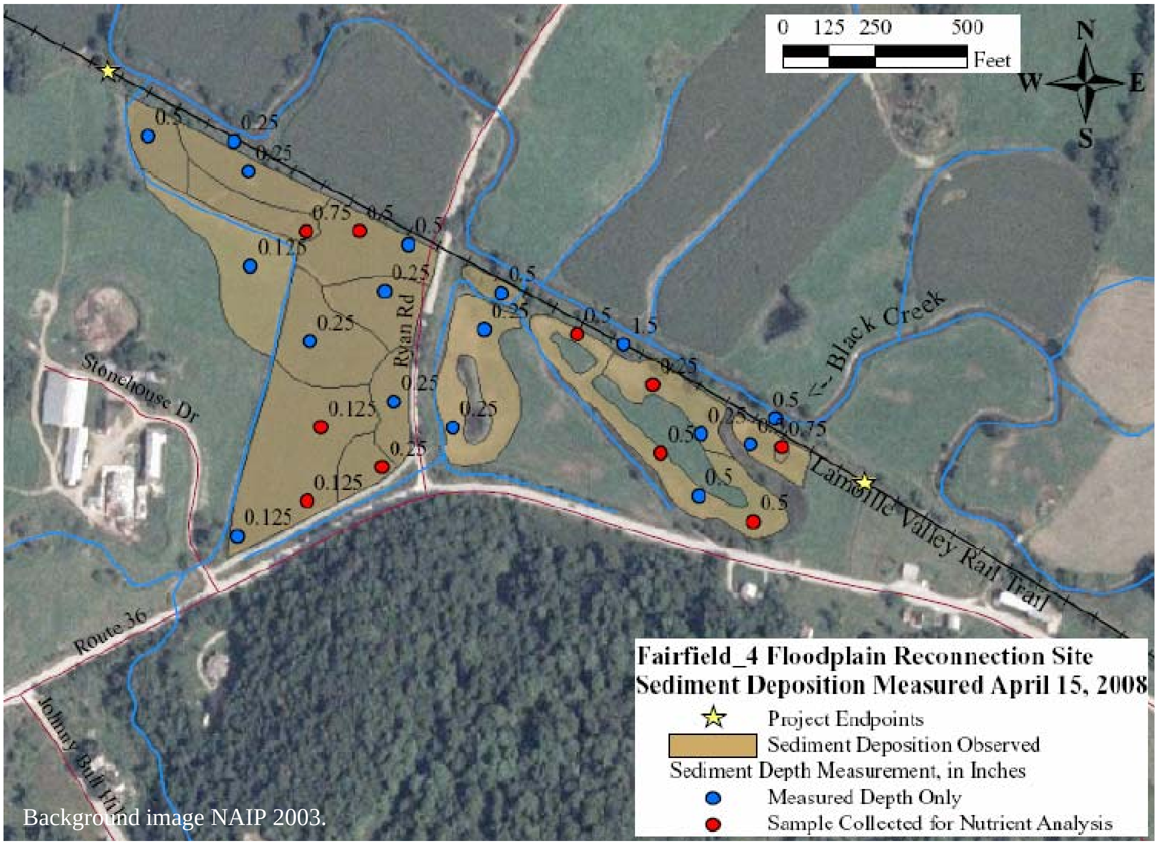
Inundated floodplain at the Fairfield_3 site. February 3, 2009, R. Schiff.

FIGURE 2
Floodplain Sediment Deposition along Black Creek

Evaluation

Evaluation monitoring was conducted at three floodplain restoration sites along Black Creek in Franklin County. The three monitored sites have an area of 21 acres of reconnected floodplain, thus representing approximately 10% of the total reconnected floodplain area for the project. The boundary of fine sediment deposited by the river on the reconnected floodplains was mapped with GPS, and sediment depth was recorded following floodplain access during spring snowmelt and storm floods (Figure 3). Composite sediment samples were collected for analysis of total Phosphorus to provide an indication of potential nutrient capture.

FIGURE 3
Mapped Floodplain Sediment Deposition along Black Creek



Volume (cubic yards) of deposited sediment was calculated for each of the floods. Using a floodplain soil bulk density of 1.3 Mg/m^3 that was estimated during previous floodplain studies in the region, total Phosphorus measurements (ppm) was converted to weight (metric tons).

Approximately 950 cubic yards of fine sediment with nearly 1.0 ton of associated total phosphorus was deposited on the three evaluated floodplains during the first spring flood following floodplain reconnection (Table 1). The level of sediment and nutrient capture on the floodplains was lower in subsequent observations and is thought to be linked to smaller floods as the extent and duration of inundation appeared to be more limited prior to floodplain observations in summer 2008 and spring 2009.

TABLE 1
Deposited Sediment Data

	Bakersfield_1		Fairfield_3		Fairfield_4 (Magnan)		Fairfield_4 (Ryan)		TOTAL	
Date	Vol (cu yd)	P (ton)	Vol (cu yd)	P (ton)	Vol (cu yd)	P (ton)	Vol (cu yd)	P (ton)	Vol (cu yd)	P (ton)
4/15/2008	261	0.2	34	0.0	400	0.5	252	0.2	**946**	**1.0**
7/29/2008	69	0.0	0	0.0	84	0.1	18	0.0	**171**	**0.1**
4/3/2009	85	0.1	14	0.0	8	0.0	93	0.1	**200**	**0.1**
6/2/2009	38	0.0	0	0.0	11	0.0	53	0.0	**102**	**0.1**
TOTALS	**453**	**0.4**	**49**	**0.0**	**502**	**0.6**	**416**	**0.3**	**1,419**	**1.3**

The mean concentration of total phosphorus in the deposited sediment (silt and fine sand) following the April 2008 flood was approximately 1,050 ± 230 mg/kg (Table 2). Mean total Phosphorus is lower in subsequent samples, and also could be linked to smaller floods.

TABLE 2
Total Phosphorus Data

	Bakersfield_1	Fairfield_3	Fairfield_4 (Magnan)	Fairfield_4 (Ryan)	TOTAL	
Date	**TP* (mg/kg)**	**TP (mg/kg)**	**TP (mg/kg)**	**TP (mg/kg)**	**Mean**	**SD**
4/15/2008	863	1260	1240	853	**1054**	**227**
7/29/2008	577	n/m	726	759	**687**	**97**
4/3/2009	909	n/m	670	644	**741**	**146**
6/2/2009	824	n/m	727	664	**738**	**81**
Mean	**793**	**1,260**	**841**	**730**	**805**	
SD	**148**	**n/a**	**267**	**96**	**168**	
*Total P was determined by microwave-assisted digestion in concentrated nitric acid (EPA Method 3051a).						
n/m = not measured						

The Bakersfield floodplain is a cutoff meander bend with native herbaceous vegetation that is hydrologically connected to a hay field across the valley. The Fairfield_3 floodplain is a mixed hay and corn field. The Fairfield_4 (Magnan) floodplain is a corn field and the Fairfield_4 (Ryan) is a hay field. Early spring samples were collected prior to commencement of manure spreading. Residual manure was observed during the June 2009 monitoring at Fairfield_3. The lack of a clear correlation between floodplain land use and total Phosphorus suggests that upstream watershed influences are likely dictating nutrient concentrations, and sediment deposition. Additional study is needed to establish a nutrient and sediment budget for the reconnected floodplains.

The removal of the former railroad embankment and reconnection of natural floodplain has led to observable sediment deposition and associated phosphorus storage. This brief evaluation study is not able to confirm the ultimate fate of the sediment and Phosphorus, yet it is believed that some or all of the sediment will reside on the floodplains over the long term, and some portion of the nutrients will be taken up during growth of wetland plants or crops. Floodplain restoration has achieved the primary project goal of reducing sediment and nutrient inputs to the Missisquoi River and Lake Champlain. Hydraulic modeling indicates that local flood and erosion risks have been reduced by floodplain reconnection.

"To put the 1.3 mt of total phosphorus deposited in those floodplains in perspective, it was more phosphorus than was discharged by 56 (out of 60) individual wastewater treatment plants in the Vermont part of the Lake Champlain Basin during 2008." (Smeltzer, November, 2009, personal communication)

It is likely that the benefits of this project are even greater than portrayed here as this evaluation only considers 3 of the 11 floodplain reconnection sites. Furthermore, larger floods and multiple floods each year are possible that could increase the potential for sediment and nutrient storage on the reconnected floodplains. This project will continue to effectively attenuate sediment and nutrient loads without additional investment for the foreseeable future and thus exemplifies a restoration approach that re-establishes natural processes.

Bibliography

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